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Procedia - Social and Behavioral Sciences 106 (2013) 1181 – 1189

Procedia
Social and Behavioral Sciences

4th International Conference on New Horizons in Education

Examining secondary school students' scientific process skills in terms of some variables

Fulya Zorlu[a*], Yusuf Zorlu[a], Fatih Sezek[b]

[a]*Atatürk Üniversity, Instute of Education, Erzurum "25100", Turkey*
[b]*Atatürk Üniversity, Faculty of Education, Erzurum "25100", Turkey*

Abstract

Every individual may come across some problems in his/her daily life. These encountered problems can be solved by taking correct decisions that lead to a solution and successfully implementing these decisions, thereby reaching a result. Scientific process is one of these methods. A number of skills are required in order to implement the scientific process in the best manner. These skills are the skills that are used by scientists during their studies, and they provide great benefits in terms of students knowing themselves and actualize their efficient learning. The aim of this study was to examine the 7th grade students' scientific process skills in terms of their demographic features. Data collection tool was used Scientific Process Skills Test. it is observed that female students are better than male students in observation, classification, measurement and model formation skills. It can be generally stated that the students, whose families have high level of education, will have more acquisitions in scientific process skills. There was no statistically significant difference between the 7th grade students' hobbies that they perform in their spare time, their selection of occupation, the programs that they watch on television and their scores on scientific process skills test.

Selection and peer-review under responsibility of The Association of Science, Education and Technology-TASET, Sakarya Universitesi, Turkey.

Keywords: **Scientific Process Skills,** Demographic Features, Secondary School Students

1. INTRODUCTION

Every individual may come across some problems in his/her daily life. These encountered problems can be solved by taking correct decisions that lead to a solution and successfully implementing these decisions, thereby reaching a result. Some methods can be followed in order to fulfill the aim in this process. Scientific process is

* Corresponding author. Tel.: +90 0442 231 44 82
E-mail address: fulyabasaran@hotmail.com

Selection and peer-review under responsibility of The Association of Science, Education and Technology-TASET, Sakarya Universitesi, Turkey.
doi:10.1016/j.sbspro.2013.12.133

one of these methods. A number of skills are required in order to implement the scientific process in the best manner. These skills are the skills that are used by scientists during their studies, and they provide great benefits in terms of students knowing themselves and actualize their efficient learning.

Students can reach the information that they require on their own using their scientific process skills in today's world where it is not possible to transfer all information from teachers to students. In this regard, scientific process skills constitute a tool for students to learn the methods of reaching information and to understand scientific studies. On the other hand, they constitute an important objective that is aimed at students in science education (Saraçoğlu, Böyük and Tanık, 2012).

Scientific process skills are defined as the skills that facilitate learning; acquire research ability; make students active in learning environments; develop their sense of responsibility in their learning; and increase retention (Akdeniz, 2005). Scientific process skills are the ways and methods that are used by scientists in reaching information and processing information (Temiz and Tan, 2003).

According to Harlen (1999, 2000) scientific process skills constitute the basis of being able to conduct scientific research. These abilities contain the abilities that can be used by every individual in every stage of life in order to become literate in science and increase quality of life and standards of living by perceiving the nature of science (Bozkurt and Olgun, 2005). These abilities were defined in a science and technology lesson plan as follows: "The skills of thinking that are used by scientists in generating information, contemplating problems and formalizing results" (MEB, 2005). They were defined by Çepni, Ayas, Johnson and Turgut (1996) as follows: "The basic skills that facilitate learning, make students active, help them to acquire responsible awareness in their learning, increase retention in learning, and acquire ways and methods of research". Helping students acquire these important skills will help them understand their own world and learn throughout their lives (Türkmen and Kandemir, 2011).

When the literature is examined (Afacan, 2008; Akdeniz, 2005; Batı and Kaptan, 2013; Yök-Dünya Bankası, 1997), it is observed that the scientific process skills are studied in 3 main sections.

1) Basic Skills: Observation, measurement, classification, recording the data and forming number and space relationships.

2) Causal Skills: Prediction, determining the variables, interpreting the data and inference.

3) Experimental Skills: Hypothesizing, using the data and forming a model, conducting an experiment, changing and controlling the variables and making a decision.

Student acquisitions are given in teacher guidebooks for Secondary Science and Technology courses of the Ministry of National Education in terms of the classification of scientific process skills (MEB, 2012). These skills are as follows:

1. Observation: They observe objects (items, entities) and situations using their sense organs or observation tools. They determine sensorial properties of an object such as shape, color, size and surface. They select appropriate tools for observation, and they use these tools skillfully.

2. Comparison-Classification: They determine qualitative and quantitative properties that will be used in classifying the objects. They detect evident similarities and differences between objects or situations. They perform comparisons according to one or more properties on the basis of observations. They perform classifications in the form of groups and sub-groups according to similarities and differences.

3. Inference: They make statements about the reasons for situations that have occurred on the basis of observations.

4. Guessing: They suggest ideas about potential results for the future on the basis of observations, inferences or experiments.

5. Prediction: They suggest ideas about approximate values by stating the appropriate units for quantities such as mass, length, time, temperature and quantity for situations and objects.

6. Determining the Variables: They determine one or several most evident variables in a given situation or relationship. They determine the dependent variable in a given situation. They determine the independent variable in a given situation. They determine the controlled variables in a given situation.

7. Hypothesizing: They state the effect of the independent variable on the dependent variable in a given situation in the form of a testable hypothesis.

8. Designing an Experiment: They suggest an experiment to test the hypothesis that they formed.

9. Recognizing and Using Experiment Materials and Tools: They select the required materials and tools in simple researches, and they use them safely and effectively.

10. Establishing an Experiment Mechanism: They establish a mechanism for conducting the experiment that they designed to test the hypothesis that they formed using the given materials.

11. Controlling and Changing the Variables: They fix the variables other than the ones about the hypothesis. They determine the effect of the independent variable on the dependent variable by changing the independent variable.

12. Functional Definition: They conclusively define the variables appropriate to the aim of the research (hypothesis) along with the measurement criterion in cases where the variables may have more than one meaning and boundaries of which have not been fully drawn.

13. Measurement: They recognize measuring tools such as ruler, thermometer, scale and timer. They determine the magnitudes using appropriate measuring tools. They express magnitudes with their units.

14. Information and Data Collection: They collect information by utilizing different sources (conducting observations and experiments in the surrounding area and classroom, using photographs, books, maps or information and communication technologies). They collect qualitative or quantitative data to test the hypothesis that they have formed.

15. Recording the Data: They record the data, which has been obtained with observation and measurement and which is appropriate to the aim of the research, via various methods such as written statements, figures, tables or drawings.

16. Data Processing and Model Formation: They show the data obtained from the experiments and observations in different forms such as observation frequency distribution, bar chart, table and physical models by compiling and processing this data. They implement the rules about drawing graphs.

17. Interpretation and Deduction: They interpret the processed data and the formed model. They reach patterns and relationships from the obtained findings.

18. Presentation: They present and share their observations, researches and the results that they have obtained in appropriate forms using verbal, written and/or visual materials.

2. Method

The aim of this study was to examine the 7^{th} grade students' scientific process skills in terms of their demographic features (gender, mother's educational status, father's educational status, number of siblings, hobbies performed in spare time, programs watched on television, frequency of reading books and selecting a future occupation).

2.1. Research Problem

Is there a relationship among the 7^{th} grade students' scientific process skills in terms of their demographic features (gender, mother's educational status, father's educational status, number of siblings, hobbies performed in spare time, programs watched on television, frequency of reading books and selecting a future occupation)?

2.2. Population and Sample

The universe of this study is composed of the 7th grade students who are studying in the secondary schools located in Erzurum province. The sample of the study is composed of the 7th grade students who are studying in two secondary schools located in Erzurum province.

2.3. Data Collection Tool

"Scientific Process Skills Test", the original of which was developed by Kathleen A. Smith and Paul W. Welliver and the Turkish translation of which was provided by Başdağ (2006), was used in this study. This test measures a total of 13 scientific process skills, namely observation, classification, inference, guessing, prediction, measurement, recording the data, forming number-space relationship, functional definition, hypothesizing, conducting an experiment, determining the variables, interpreting the data, and model formation. The test is composed of 40 questions. The reliability of the test was determined as 0.81 by Başbağ.

3. Findings and Interpretation

When Table 1 was examined, it was observed that there was a statistically significant difference between the genders of the 7th grade students and the scores that they achieved on the SPST in favor of female students ($t=2,205$; $p<0,05$). It was observed that the average score of female students was 30.46 in the SPST whereas the average score of male students was 27.87.

Table 1. Independent t-test results of the 7th grade students' scores on the SPST in terms of gender

Gender	N	X	S	t	p
Female	65	30,46	6,36	2,205	0,029
Male	67	27,87	7,13		

When Table 2 was examined, it was observed that there was a statistically significant difference between the genders of the 7th grade students and their scores on observation, classification, measurement and model formation skills ($p<0,05$). It was observed that the score averages of female students were higher than the score averages of male students. It was observed that female students were better at observation, classification, measurement and model formation skills than male students.

Table 2. Independent t-test results of the 7th grade students' scores on the scientific procces skills in terms of gender

Skills	Gender	N	X	S	T	p
Observation	Female	65	1,68	0,56	2,789	0,006
	Male	67	1,33	0,84		
Classification	Female	65	2,12	1,21	2,041	0,043
	Male	67	1,70	1,17		
Measurement	Female	65	4,89	1,29	2,346	0,020
	Male	67	4,39	1,18		
Model Formation	Female	65	0,78	0,41	2,719	0,007
	Male	67	0,57	0,50		

When Table 3 was examined, it was observed that there was a statistically significant difference between the educational status of the mothers of the 7th grade students and the scores that they achieved on the SPST (F_{4-131}=3,504; p<0,05).

Table 3. One-Way ANOVA results of the 7th grade students' scores on the SPST in terms of the educational status of their mothers

Source	Sum of Squares	df	Mean Squares	F	p
Between Groups	613,140	4	153,285	3,504	0,009
Within Groups	5555,125	127	43,741		
Total	6168,265	131			

When Table 4 was examined, it was observed that there was a statistically significant difference between the educational status of the mothers of the 7th grade students and their scores on measurement, hypothesizing and data interpretation skills (p<0,05). It was observed that the score averages of the students whose mothers were graduates of elementary school, secondary school, high school and university ranged from 4.84 to 4.64 in measurement skills whereas the score averages of the students whose mothers were only literate was 3.68. It was observed that the score averages of the students whose mothers were graduates of elementary school, secondary school, high school and university ranged from 1.45 to 1.32 in hypothesizing skills whereas the score averages of the students whose mothers were only literate was 0.84. It was observed that the score averages of the students whose mothers were graduates of elementary school, secondary school, high school and university ranged from 4.33 to 3.47 in data interpretation skills whereas the score averages of the students whose mothers were only literate ranged from 2.78 to 2.32.

Table 4. One-Way ANOVA results of the 7th grade students' scores on the scientific procces skills in terms of the educational status of their mothers

Skills	Source	Sum of Squares	df	Mean Squares	F	p
Measurement	Between Groups	20,343	4	5,086	3,469	0,010
	Within Groups	186,203	127	1,466		
	Total	206,545	131			
Hypothesizing	Between Groups	6,019	4	1,505	2,632	0,037
	Within Groups	72,617	127	0,572		
	Total	78,636	131			
Data Interpretation	Between Groups	40,411	4	10,103	4,053	0,004
	Within Groups	316,581	127	2,493		
	Total	356,992	131			

When Table 5 was examined, it was observed that there was a statistically significant difference between the educational status of the fathers of the 7th grade students and the scores that they achieved on the SPST (F_{4-131}=3,504; p<0,05).

Table 5. One-Way ANOVA results of the 7th grade students' scores on the SPST in terms of the educational status of their fathers

Source	Sum of Squares	df	Mean Squares	F	p
Between Groups	578,147	4	144,537	3,284	0,013
Within Groups	5590,118	127	44,017		
Total	6168,265	131			

When Table 6 was examined, it was observed that there was a statistically significant difference between the educational status of the fathers of the 7th grade students and their scores on guessing, measurement and variable determination skills (p<0,05). It was observed that the score averages of the students whose fathers were graduates of elementary school, secondary school, high school and university ranged from 5.06 to 4.19 in measurement skills whereas the score averages of the students, whose fathers were only literate was 3. It was observed that the score averages of the students whose fathers were graduates of elementary school, secondary school, high school and university ranged from 2.52 to 2.5 in variable determination skills whereas the score averages of the students whose fathers were only literate was 0.5. It was observed that the score averages of the students whose fathers were graduates of elementary school, secondary school, high school and university ranged from 4.44 to 4.11 in guessing skills whereas the score averages of the students whose fathers were only literate was 2.

Table 6. One-Way ANOVA results of the 7th grade students' scores on the scientific procces skills in terms of the educational status of their fathers

Skills	Source	Sum of Squares	df	Mean Squares	F	p
Guessing	Between Groups	12,832	4	3,208	3,291	0,013
	Within Groups	123,797	127	0,975		
	Total	136,629	131			
Measurement	Between Groups	17,379	4	4,345	2,917	0,024
	Within Groups	189,167	127	1,490		
	Total	206,545	131			
Variable Determination	Between Groups	15,789	4	3,947	2,668	0,035
	Within Groups	187,870	127	1,479		
	Total	203,659	131			

When Table 7 was examined, it was observed that there was a statistically significant difference between the number of siblings of the 7th grade students and the scores that they achieved on the SPST (F_{5-131}=2,483; p<0,05).

Table 7. One-Way ANOVA results of the 7th grade students' scores on the SPST in terms of the number of siblings

Source	Sum of Squares	df	Mean Squares	F	p
Between Groups	553,237	5	110,647	2,483	0,035
Within Groups	5615,028	126	44,564		
Total	6168,265	131			

When Table 8 was examined, it was observed that there was a statistically significant difference between the number of siblings of the 7th grade students and their scores on measurement, hypothesizing and variable determination skills. It was observed that the scores of the students decreased generally in measurement, variable determination and guessing skills when the number of siblings increased.

Table 8. One-Way ANOVA results of the 7th grade students' scores on the scientific procces skills in terms of the number of siblings

Skills	Source	Sum of Squares	df	Mean Squares	F	p
Measurement	Between Groups	18,554	5	3,711	2,487	0,035
	Within Groups	187,992	126	1,492		
	Total	206,545	131			
Hypothesizing	Between Groups	7,456	5	1,509	2,675	0,025
	Within Groups	71,091	126	0,564		
	Total	78,636	131			
Variable Determination	Between Groups	24,233	5	4,487	3,403	0,006
	Within Groups	179,426	126	1,424		
	Total	203,659	131			

When Table 9 was examined, it was observed that there was no statistically significant difference between the 7th students' frequency of reading books and the scores that they achieved on the SPST. No relationship was observed between the frequency of reading books and their scientific process skills ($F_{2\text{-}131}$=2,483; p>0,05).

Table 9. One-Way ANOVA results of the 7th grade students' scores on the SPST in terms of frequency of reading books

Source	Sum of Squares	df	Mean Squares	F	p
Between Groups	59,797	2	29,899	0,631	0,533
Within Groups	6108,468	129	47,352		
Total	6168,265	131			

When Table 10 was examined, it was observed that there was no statistically significant difference between the 7th grade students' hobbies that they performed in their spare time and the scores that they achieved on the SPST ($F_{4\text{-}374}$=0,789; p>0,05). No relationship was observed between the 7th grade students' hobbies that they performed in their spare time and their scientific process skills.

Table 10. One-Way ANOVA results of the 7th grade students' scores on the SPST in terms of hobbies that they performed in their spare time

Source	Sum of Squares	df	Mean Squares	F	p
Between Groups	75,822	4	18,956	0,427	0,789
Within Groups	16436,327	370	44,423		
Total	16512,149	374			

*Students marked more than one option.

When Table 11 was examined, it was observed that there was no statistically significant difference between the 7th grade students' selection of a future occupation and the scores that they achieved on the SPST ($F_{11\text{-}131}$=0,789; p>0,05). No relationship was observed between the 7th grade students' selection of a future occupation and their scientific process skills.

Table 11. One-Way ANOVA results of the 7th grade students' scores on the SPST in terms of selection of a future occupation

Source	Sum of Squares	df	Mean Squares	F	p
Between Groups	899,453	11	81,768	1,862	0,051
Within Groups	5268,812	120	43,907		
Total	6168,265	131			

When Table 12 was examined, it was observed that there was no statistically significant difference between the programs watched on television by the 7th grade students and the scores that they achieved on the SPST (F_{7-446}=0,789; p>0,05). No relationship was observed between the programs watched on television by the 7th grade students and their scientific process skills.

Table 12. One-Way ANOVA results of the 7th grade students' scores on the SPST in terms of the programs watched on television

Source	Sum of Squares	df	Mean Squares	F	p
Between Groups	467,592	7	66,799	1,367	0,217
Within Groups	21451,325	439	48,864		
Total	21918,917	446			

*Students marked more than one option.

4. Results

When we look at the genders of the 7th grade students and the scores that they achieved on the scientific process skill test, it is observed that female students are better than male students in observation, classification, measurement and model formation skills. The effect of the educational status of their mothers on their measurement, hypothesizing and data interpretation skills are clearly observed. It is observed that the students, whose mothers were only literate, generally achieved lower scores on these skills. The effect of the educational status of their fathers on their measurement, guessing and variable determination skills are clearly observed. It is observed that the students whose fathers were only literate generally achieved lower scores on these skills. It is observed that the educational status of the families of the students is very important for the education of these students. It can be generally stated that the students, whose families have high level of education, will have more acquisitions in scientific process skills. It is observed that the scores of the students generally decrease in measurement, variable determination and guessing skills when the number of siblings increases. A general decrease was observed in the scores of the students who have four or more siblings. It is known that a general decrease occurs in family's paying attention to the condition of the student at school when those families have a high number of siblings. This condition can cause a failure for students in fully overcoming their insufficiencies. It was observed that there was no relationship between students' frequency of reading books and their scientific process skills. However, it is considered that the students did not sincerely answered the question, "How often do you read books?". It was observed in the researches conducted in the literature that the students who have a habit of reading books will be better at scientific process skills (Aydoğdu, 2006). There was no statistically significant difference between the 7th grade students' hobbies that they perform in their spare time, their selection of occupation, the programs that they watch on television and their scores on scientific process skill test.

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